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GRD RESEARCH NOTES
No. 53

GRAVITY OBSERVATIONS ALONG THE NORTHERN COAST OF ELLESMERE ISLAND

Francis A. Crowley

February 1961

GEOPHYSICS RESEARCH DIRECTORATE
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AIR FORCE RESEARCH DIVISION (ARDC)
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

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Project 7628
Task 76282

Terrestrial Sciences Laboratory
GEOPHYSICS RESEARCH DIRECTORATE
AF CAMBRIDGE RESEARCH LABORATORIES
AIR FORCE RESEARCH DIVISION (ARDC)
UNITED STATES AIR FORCE
Bedford, Mass.

ABSTRACT

Free air gravity anomalies are tabulated for a remote section of the Northern Ellesmere coast in the vicinity of Ward Hunt Island. A moderately positive reduced free air anomaly is found over a section of known bathymetry.

GRAVITY OBSERVATIONS ALONG THE NORTHERN COAST OF ELLESMERE ISLAND

INTRODUCTION

During the Spring of 1961, some 90 gravity stations were taken along the northern coast of Ellesmere Island between McClintock and Markham Fjords. Although the first purpose of this survey was to obtain a better understanding of the composition, structure, and elevation of the formations underlying the Ward Hunt Ice Shelf, the observations have an immediate value in that they provide some coverage for an extremely remote region. For this reason, a reduced free-air estimate has been obtained for this segment of the Ellesmere Coast.

OBSERVATIONS

Sea-level estimates of gravity are given in the form of free-air anomalies in Table 1. These estimates are based on a gravity value of 982.9344 gal. for Hangar 1, Thule, Greenland[1] and the international formula, as tabulated by the Coast and Geodetic Survey.[2]

OBSERVED ERROR

A standard deviation of 0.25 mg was observed for repeated measurements after a correction for instrument drift was applied. The ability to repeat gravity observations over the Ice Shelf reflects not only an uncertainty in estimating instrument drift and observer errors, but also an uncertainty in elevation due to tidal action on the Shelf.[3] Tidal observations taken in the Summer of 1959 and 1960 point to a substantial areal variation in the daily tide both in amplitude and phase. An elevation uncertainty of the order of one meter (~ 0.25 mg) can be expected during the period from tidal action.

ELEVATION CORRECTION

A free-air correction to sea level was applied to the observations taken over the floating ice shelf. Since the Ice Shelf has a maximum elevation < 7.0 meters, and generally less, errors

(Author's manuscript approved 17 February 1961).

associated with this correction will be quite small. The precision of the elevation estimates over the Shelf should be of the same order as the tidal uncertainty.

STATION LOCATION

Station locations were determined by triangulations to the local coastal peaks plotted on a "1 inch to the mile" chart prepared by the Legal Surveys and Aeronautical Charts Division of the Department of Mines and Technical Surveys.[4] Checks of these chart positions by dead-reckoning estimates are in good agreement (0.5 km of Lat.). Undoubtedly the largest position uncertainty lies in the chart itself, for the control for the chart is based on a series of sun shots.

RESULTS

The large free-air anomalies appearing in the table reflect the variation in ocean depth due to elongated coastal deeps. Along a surveyed line over the Ice Shelf the gravity stations have complementary water depths, determined by seismic measurements. Relatively good correspondence between the gravity and seismic data can be obtained by forming a simple two-dimensional model of the deep using a material density of 2.5 g/cm^3 with the long axis of the deep coursing at right angles to the survey line, Fig. 1. When this model is used as a geological terrain correction, a reduced free-air anomaly of + 6.6 mg is obtained for the line. In this case, the mean depth of the line (350 meters) is used as a center line for model (Table 2).

SUMMARY

The observations made along the northern coast of Ellesmere Island have general value due to the remoteness of the location. They are apparently in accord with the moderately positive values found in the Arctic Ocean.[5] The free-air values thus found, evidence the expected transition between Arctic Ocean values and the dominantly negative free-air values to be expected in high relief of the interior of Ellesmere.

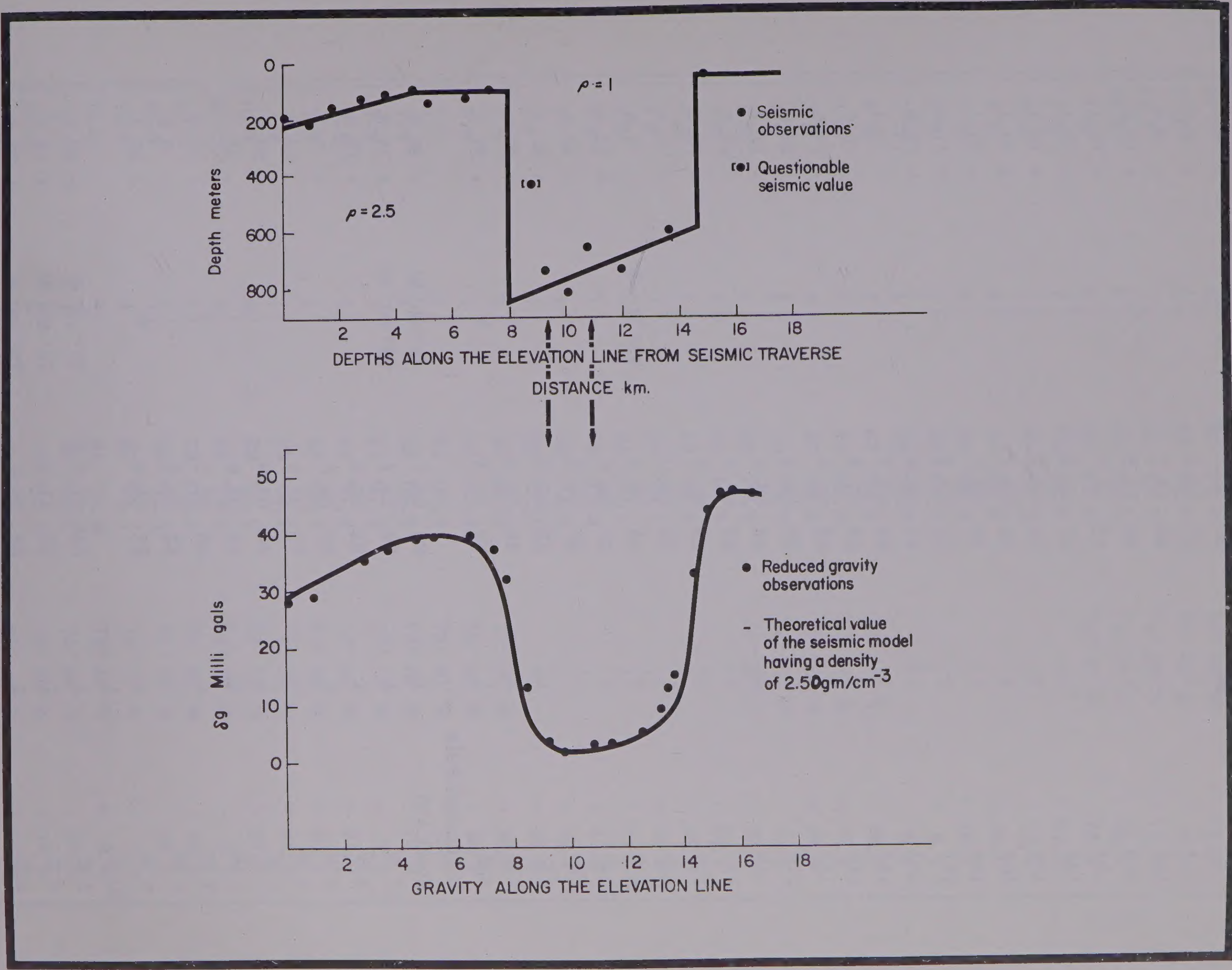

Fig. 1. Gravity model.

TABLE 1.

Station Symbol	Number of Observations	Latitude	Longitude	Free Air Anomaly
L-1	20	83° 06.3' N	75° 25' W	+ 34.1
101	5	83 12.2		+ 8.9
102	1	83 11.7		+ 9.4
103	1	83 11.3		+ 12.1
104	2	83 10.7		+ 16.1
105	16	83 10.3		+ 17.1
106	4	83 09.7		+ 19.1
108	1	83 09.4		+ 20.1
109	1	83 08.7		+ 20.1
111	1	83 08.3		+ 17.8
112	1	83 08.0		+ 12.6
113	2	83 07.7		- 6.1
115	9	83 07.3		- 16.0
116	1	83 06.9		- 17.6
118	2	83 06.4		- 16.6
119	2	83 06.0		- 16.2
121	1	83 05.5		- 14.5
124	1	83 05.1		- 10.1
125	1	83 05.0		- 6.9
126	2	83 04.9	75° 30' W	- 4.6
127	1	83 04.5		+ 12.9
130	1	83 04.2		+ 23.8
131	1	83 03.9		+ 27.3
132	2	83 03.7		+ 27.7
133	1	83 03.3		+ 27.2
Unmarked Pole South 133	1	83 03.1	75° 30' W	+ 26.6
1 W	1	83 11.7	76° 00 W	+ 14.8
2 W	1	83 10.8		+ 13.8
3 W	1	83 09.8		+ 4.1
4 W	4	83 08.8		- 19.3
5 W	1	83 07.9		- 30.8
6 W	1	83 06.8		- 26.8
7 W	1	83 06.1		- 16.8
8 W	1	83 05.6		- 0.8
9 W	1	83 05.2		+ 20.4
10 W	1			
1 E	1	83° 12.9' N	75° 10' W	+ 10.5
2 E	1	83 11.9	75° 05' W	+ 14.5
3 E	1	83 10.8	75° 05' W	+ 23.8
4 E	1	83 09.8	75° 05' W	+ 29.2
5 E	1	83 09.0	75° 05' W	+ 32.0
6 E	1	83 07.9	74° 55' W	+ 32.1
7 E	1	83 06.9	74° 55' W	+ 31.1
8 E	1	83 06.4	74° 50' W	+ 24.2
9 E	1	83 05.5	74° 50' W	- 6.4

Table 1

TABLE 1. (continued)

Station Symbol	Number of Observations	Latitude	Longitude	Free Air Anomaly
10 E	1	83 05.0' N	74° 50' W	- 9.3
11 E	1	83 04.3	74° 50' W	- 12.5
12 E	1	83 03.5	74° 45' W	- 6.0
13 E	1	83 03.2	74° 45' W	+ 12.1
14 E	1	83 02.9	74° 45' W	+ 28.1
1 B	1	83 13.4	73° 20' W	+ 23.2
2 B	1	83 12.2		+ 24.2
3 B	1	83 11.2		+ 23.4
4 B	1	83 09.9		+ 25.1
5 B	1	83 08.8		+ 19.1
6 B	1	83 07.7		+ 4.1
7 B	1	83 06.7		- 5.1
8 B	1	83 05.5	73° 15' W	+ 25.3
1 C	1	83 05.8	73° 55' W	+ 31.8
2 C	1	83 04.5	74° 00' W	+ 18.9
3 C	1	83 03.7	74° 05' W	- 5.3
1 R	1	83 06.9	74° 05' W	+ 29.6
2 R	1	83 07.7		+ 34.4
3 R	1	83 08.7		+ 35.2
1 S	1	83 09.1		+ 34.8
2 S	1	83 10.1		+ 35.0
3 S	1	83 11.3		+ 32.4
4 S	1	83 12.3		+ 25.2
5 S	1	83 13.1		+ 27.8
7-1	1	83 06.2	73° 50' W	+. 28.0
7-2	1	83 06.3	73° 45' W	+ 25.8
7-3	1	83 06.3	73° 30' W	+ 12.6
7-4	1	83 06.5	73° 20' W	+ 13.0
7-5	1	83 07.2	73° 20' W	+ 9.2
7-6	1	83 07.7	73° 30' W	+ 21.9
7-7	1	83 08.1	73° 40' W	+ 26.7
7-8	1	83 08.1	73° 55' W	+ 31.2
10-1	2	83 05.0	74° 15' W	+ 27.6
10-2	1	83 04.2	74° 10' W	- 6.2
10-3	1	83 03.2	74° 10' W	- 16.6
10-4	1	83 02.4	74° 10' W	- 18.1
10-5	1	83 01.5	74° 10' W	+ 2.0
10-6	1	83 01.2	74° 10' W	+ 8.4
10-7	1	83 01.7	73° 40' W	+ 30.8
10-9	1	83 02.0	73° 40' W	+ 19.4
10-10	1	83 02.4	73° 45' W	+ 12.5
10-11	1	83 02.9	73° 55' W	+ 16.4
10-12	1	83 03.5	74° 00' W	+ 6.5

Initial: Thule Ob. 982.9344 (Hangar 1)

Final: " " 982.9346

(Obs. Standard dev. < 1/4 mg.)

Table 1 (continued)

TABLE 2.

Station Symbol	Free Air Anomaly	For Seismic Model $\bar{d}$ = 350 Meters	Observed Anomaly Less Seismic Model
101	+ 8.9 mg	+ 3.2 mg	+ 5.7 mg
102	+ 9.4	+ 5.5	+ 3.9
103	+ 12.1	+ 7.1	+ 5.0
104	+ 16.1	+ 9.7	+ 6.4
105	+ 17.1	+ 11.0	+ 6.1
106	+ 19.1	+ 13.1	+ 6.0
108	+ 20.1	+ 13.3	+ 5.6
109	+ 20.1	+ 12.1	+ 8.0
115	- 16.0	- 22.7	+ 6.7
116	- 17.6	- 24.2	+ 6.6
118	- 16.6	- 23.9	+ 7.3
119	- 16.2	- 23.3	+ 7.1
121	- 14.5	- 21.8	+ 7.3
131	+ 27.3	+ 19.8	+ 7.5
132	+ 27.7	+ 19.7	+ 8.0
133	+ 27.2	+ 19.7	+ 7.5
134	+ 26.6	+ 19.7	+ 6.9
		$\bar{x}$ =	+ 6.6
		s =	1.00

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